

A Comprehensive CFD Tool for Aerothermal Environment Around Space Vehicles

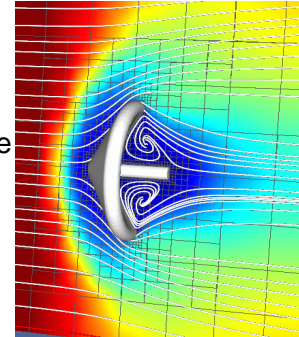
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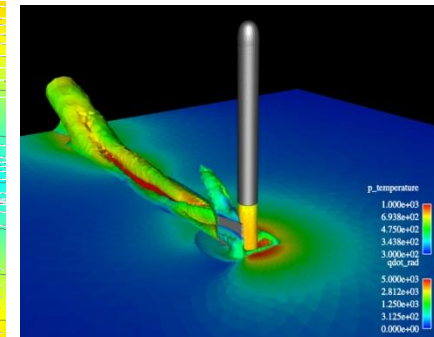
Identification and Significance of Innovation

- **Accurate computational models** to predict aerothermal environment for hypersonic trans-atmospheric flight for the **entire range of altitudes and flow conditions**
- **Smart software with self-aware physics and adaptive numerics** coupling non-equilibrium chemistry, multi-scale radiation transport and plasma capabilities for hypersonic flows
- **Adaptive Mesh and Algorithm Refinement** capabilities for automatic mesh generation, dynamic adaptation of mesh and physics to flow conditions

Expected TRL Range at the end of Contract (1-9): 6



IRVE,
90 km altitude
 $M=4$,
 $Kn=0.01$

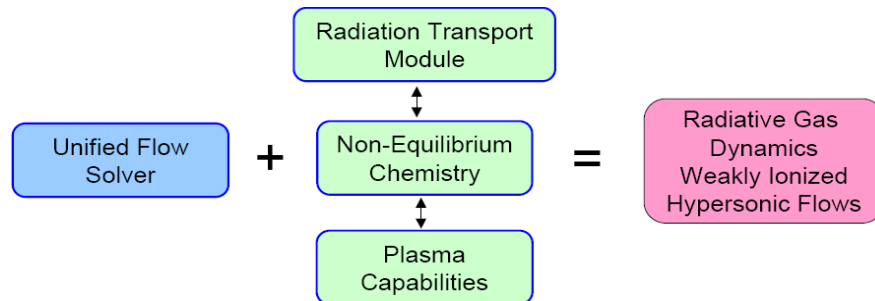


(Left) UFS simulations of Inflatable Reentry Vehicle Experiment (IRVE): streamlines, and Mach number contours.

(Right) Radiative heat flux contours on the launch pad due to gaseous and particle radiation from the plume of a solid rocket motor.

Technical Objectives and Work Plan

- CFDRC has developed a Unified Flow Solver (UFS) for **rarefied, transitional, and continuum flows**.
- The goal of this SBIR project is to enhance and apply UFS to hypersonic flows by adding advanced, high-fidelity physical models: non-equilibrium chemistry, multi-scale radiation transport, and plasma capabilities.



NASA and Non-NASA Applications

- Proposed computational tool will enable NASA and government contractors to better design and analyze future hypersonic vehicles.
- The tool will be directly relevant to research on hypersonics, high-speed boundary layer flows, gas turbine combustion, including radiative heat transport in high-temperature reacting flows, aerothermodynamics, high-temperature materials processing, and plasmadynamics
- At the end of Phase II, a design tool for plasma flow control for subsonic and supersonic aerospace vehicles will be available.
- The CFD tool will have applications in high speed flows for material processing, chemical, and biomedical applications

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